I am drawing on that lively period of scientific enterprise to find fuel for yet another revolution, one that focuses on the very conception of science itself.

The science of cell biology is very different from the textbook image of science, including that advanced in traditional philosophy of science. That picture, grounded on some of the great successes of the scientific revolution and subsequent developments in some areas of physics, emphasizes bold unifying generalizations – the laws of nature. Newton's laws of motion promised to explain all motion, both terrestrial and celestial. The laws of thermodynamics and electromagnetism are similarly broad in their sweep. In biology, Darwin's insight that evolution by natural selection occurs when there is heritable variation in fitness (Lewontin, 1970) has provided a similarly powerful unifying generalization. However, most areas of biology – including cell biology – do not fit into this picture. Instead of unifying generalizations, cell biology offers detailed accounts of complex mechanisms in which different component parts perform specific operations, which are organized and orchestrated so that a given type of cell can accomplish the functions essential for its life. Not elegant generalizations, but exquisitely detailed accounts of mechanisms, are the products. This difference in product has broad implications for our overall understanding of science, including the challenges of generating evidence, advancing new hypotheses and theories, and evaluating and revising them.

In proposing an alternative characterization of science as the search for mechanisms, I am not seeking to eradicate the old picture of science as the quest for bold generalizations but to complement it. There are domains in which the Newtonian vision is appropriate – ones in which the aim of inquiry is best served by far-reaching generalizations that can be economically stated, often in a single equation. In many domains, though, the aim of inquiry leads to meticulous accounts of complex mechanisms. This is particularly true in the functional domains of biology – cell biology, molecular biology, physiology, pathology, developmental biology, neurobiology – and also in related areas of physics (biophysics) and chemistry (biochemistry). It does not advance our understanding of these sciences to impose an ill-fitting model. Rather, we need to develop a conception of science that is appropriate for them. Only then can we adequately address some of the traditional questions about science – what it is to explain a phenomenon, how explanations are discovered, and how they are evaluated.

The idea that much of science is a quest to articulate mechanisms is not news to biologists. Frances Crick (1988, p. 138) put it succinctly:

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